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ABSTRACT

Changes in the design and implementation of instructional simulations on the PLATO IV system have evolved in the direction of more explanation, evaluation, and streamlined simulation. Student pressure to use their own problem solving processes, the practical system limitations of producing environmentally complex simulations, and student confusion when no guidance was given have all contributed to a change in instructional goals and new directions in the development of instructional simulations. New formats combine feedback on each action taken, guidance or explanation in reaching the goal, and less realistic simulations. Instructional goals are now emphasizing concept learning rather than skill in problem solving. Current trends indicate continued use of simple simulations with the increasing use of non-traditional formats, and the use of sound, as well as more individualization of lesson development. Thirteen references are included as well as a selected annotated listing of instructional simulations and games arranged by subject areas. (BK)

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THE EVOLUTION OF PLATO INSTRUCTIONAL SIMULATIONS

by

Lisa P. Brenner
and
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THE EVOLUTION OF PLATO INSTRUCTIONAL SIMULATIONS

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The PLATO IV system was the product of experimentation with computer-based instruction in a University environment. Designed with advanced graphics, and providing each user with access to the computational capability of a large computer, it encouraged development of the rich library (Lyman, 1977) of instructional simulations now available on PLATO. This paper traces the evolution of simulations from the beginning of PLATO IV in order to show how the use of an educational tool changes as a development community gains experience. It focuses on simulations developed at the University of Illinois. The authors have been members of its development community since PLATO IV began, and can thus report change in personal attitudes and development practices within this context.

During its early years of rapid growth with significant Federal support and direction, a large community of authors formed in Urbana with a dominant attitude that PLATO was a new medium for which existing principles had little application (Steinberg, 1975). Few authors had formal training in computer programming or educational design. The goals of these people were creative and instructional in nature rather than analytical, and they quickly became immersed in this rich, new educational environment.

The PLATO environment has changed in the last seven years. Terminals are no longer centralized at the Computer Based Education Research Laboratory, but are located throughout the University and the country. PLATO is available as a commercial product and in conjunction with microprocessor-based systems. Initiatives for curricular development are no longer dominated by Federal interests. PLATO has become an accepted fixture in the University instructional program rather than an experiment. The authoring community has also decentralized and face-to-face communication between authors has to a great extent been replaced with PLATO communications.

Definitions of a research simulation are easy to agree on (Coombs, 1976), but this is not the case with educational simulations. Agreement appears to exist defining educational simulations as models involving processes, but a uniform definition of methods of implementation and goals (other than that of teaching) is not readily discernable. We avoid taxonomies in this discussion because the PLATO environment provides such a diversity of instructional material defined by the authors as simulations that we were hard pressed to agree on a single definition or cut-off point for consideration of a lesson as a simulation. On the whole this paper discusses <u>only</u> mainline educational simulations.

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This paper focuses on changes that have occurred in the use of instructional simulations, characterizing trends in the physical representation of simulations, goals and methods of reaching goals, and the incorporation of gaming elements in the simulation format. We will not address their internal structures or programming techniques.

A NEW TOY

Given unprecedented computational and graphic capabilities, authors easily became preoccupied with the challenge of creating simulations which were close representations of the modeled environment. Students, the public, and funding agencies were terribly impressed and entertained by complex graphics and dialogues. The face value credibility of verisimilitude was frequently the only evaluation that simulations were subjected to.

Consequently, great attention was placed on representing water flowing in and out of beakers, realistic and complete patient/doctor dialogues, mice which appeared to run around their conditioning box eating their rewards, and jurors who stood as the judge entered the courtroom. These details were considered necessary to convince students to take the exercises seriously and to facilitate transfer from the simulation to the real environment. Beneath these rationalizations lay the fun of creating works of art and the thrill of producing educational materials that were entertaining. Politically, this emphasis was very helpful, for much of PLATO's tremendous popular acceptance (Magarrell,1978) is attributable to its rich representational capabilities.

The educational disadvantages of meticulous attention to minor details in a simulated environment had already been discovered and documented in motor-skill learning literature. PLATO IV authors soon began to make the same discoveries when attempting to teach cognitive skills (Parker, 1976) via simulations to significant numbers of students.

A simulation isolates critical aspects of an environment and then provides the student with practice in this limited setting. Excessive detail often serves only to divert attention from important to insignificant elements of the modeled processes. It may also add a significant amount of time and tedium to the learning experience and make it difficult to generalize the program to a variety of encounters. High fidelity simulations also made heavy demands on the PLATO system which ultimately could not be met when a large number of users connected to the system. This was a severe blow to many lesson designers, even though the descending limits were well advertised. The microprocessor-based PLATO V terminal again provides the individual user with unprecedented new capabilities; but limited distribution of these terminals and a current shortage of hardware and software support has limited application.
After seven years, efficient simulations based on either a representation of critical features only or on a non-representational structure which facilitates demonstration/practice of a process are becoming more prevalent. "Diagnose", a lesson teaching differential diagnosis of human diseases, (Nelson, 1979) is a current example of a non-representational

simulation in an educational environment. Students are provided with an abbreviated statement of a patient's complaints, then a list of 60 possible diagnoses for the complaint. The student indentifies reasonable diagnoses. The cycle is repeated against the list of selected diagnoses with additional information until a final diagnosis is given. A debriefing presents statistics on choices made by other students as well as experts' selections.

The setting for "Diagnose" bears no resemblence to a "real" doctor/patient interchange. There is no dialogue or examination; the student does not choose which step to take next; no recall is required. The lesson focuses on the process of elimination in diagnosis. Diagnose is the most frequently selected and heavily used medical lesson since its completion in 1977, having been used by medical students for about 250 hours in 1977-78, compared with 50 hours for the traditional Physician Self Assessment patient/dialogue simulations available on the medical catalog (Brenner, 1979). New cases are easily added to the set, and the lesson is useful to students many times over.

INSTRUCTIONAL GOALS

Demonstration

Most simulations on PLATO demonstrate a process or concept. Their goals are to teach principles, not to provide students with skill in executing the process itself. Through the use of visual representations, sequences of simulation state histories, and animations, authors are able to illustrate concepts in an interactive environment. Brief simulations are embedded in tutorial lesson sequences throughout PLATO, particularly in the physical and bio-science lessons (Sherwood, 1977). The population dynamics group (Handler, 1972) has developed a large set of demonstration simulations, with the goal of instructing Third World politicians in the effects of economic and social changes on their populations. The user may vary parameters such as agriculture production and capital investment, seeing the general effects that these changes would cause on the countries populations represented through comparative graphs.

Teaching a Process or Skill

Many early PLATO lessons attempted to teach a process by presenting the student with a simulated environment in which the student is allowed to "sink or swim" with little or no assistance. Simulations of this type tended to sink. Early versions of a behavioral laboratory for conditioning mice illustrates the problem. The student could choose to put food into the cage, activate or disable the manipulandum, or choose a new animal. If the mouse received too much food it would no longer respond. The simulation worked perfectly if you knew what to do, but was incomprehensible if you did not. The value of trial and error practice was that students could try out incorrect procedures and discover their consequences in an environment where a simulated accident did only simulated damage. On the other hand, students had limited means of identifying exactly what went wrong and why. Trial and error at best is

a very inefficient method of learning.

One method of dealing with student floundering was to provide students with a list of things to try (Sherwood, 1971.) Another common solution has been to force students to take the "appropriate" sequence of steps through the simulation. For example, this technique was used by the Veterinary Medicine Department in their laboratory simulation of indentification of bacteriologic unknowns (Grimes, 1972), early versions of genetics laboratory simulations, and chemistry labs. The chemistry lessons illustrating laboratory procedures (Smith, 1974) of titration and fractional distillation require the student to select and set up laboratory equipment, initiate and observe a process until a critical point is reached, and draw appropriate conclusions. The program stops students when a gross error is attempted, such as assembling the apparatus awkwardly. While it makes learning more efficient, this solution can deny students the benefits of simulated failure.

A third solution is to assist the student by including a "concerned observer" in the process who interrupts or provides help on request at each stage of the simulation. This approach allows the student to experiment, but also moniters behaviors and requires the student to analyze and understand cause and effects. Many clinical simulations have a Doctor Hippocrates lurking in the background, asking embarrassing questions when students attempt inappropriate procedures, as well as making sure that correct procedures have been chosen for good reasons. This approach leaves students free to experiment, but makes sure that they learn from their mistakes.

A fourth approach is to debrief the student after the simulation is complete. This technique is illustrated in a genetics laboratory simulation in which students provide genetic counselling to simulated patients. After the student has finished the process of history taking, examination, laboratory testing, calculation, and counselling, the program lists each step the student took in the process and compares it with the author's "expert" process. Steps are marked as "necessary", "acceptable", "unnecessary", and "harmful". While a recommended order is presented to students, the authors avoid prescription.

Inductive Learning Skills

At the same time that PLATO lesson production began to flourish, there was much interest in the educational community in critical thinking skills, specifically in inductive learning. This interest was carried over to PLATO, where a major goal of many early PLATO simulations was to provide an environment which would foster inductive learning skills.

At the University of Illinois, a number of simulations illustrating concepts and processes in Political Science (Coombs, 1971) were developed in which students were to develop an understanding of principles while exercising their inductive skills. The simulations were of processes such as running an election campaign, negotiating a union contract with a school board, and passing a bill in congress. These lessons were used

extensively by Political Science students for several years. They are still operational, but not currently in regular use by the University of Illinois Political Science department. The developer of the lessons, Fred Coombs, has indicated that students often had to repeat the simulations a number of times before "discovering" the principles being illustrated, and sometimes missed the point altogether. He felt in retrospect that if the simulations had contained guidance materials pointing out the important principles to be observed, students would have spent less time and learned more from them. He also indicated a general disenchantment with instruction in inductive learning skills paralleling a similar change in social science education.

Changes in Goals and Techniques

It appears that many simulations which were developed for the purpose of teaching a skill have in fact had the effect of teaching knowledge. The genetics lab lesson previously mentioned was originally written in 1974 with the intention of teaching the process. At first, the simulation forced students into using the "correct" procedures. Students protested that they had a right to use their own process. It became apparent that 1) the "process" being imposed was trivial and 2) an environment in which students could practice the integration and utilization of concepts had been the real underlying goal. So the attempt to teach a problem solving process was discarded and the emphasis was placed on providing feedback concerning the efficiency of each action taken.

It could almost be said that as a rule, simulations which have been maintained and revised over a period of years have evolved in the direction of a combination of explanation, evaluation and streamlined simulation. Most simulations discussed in this paper have been significantly revised in these directions. Designers are recognizing that they cannot throw a student into an unfamiliar simulated environment and expect learning to magically occur. Foregoing some assumptions about problem solving processes and realizing that instructional goals are often quite specific, authors are increasing student freedom in choosing a path through simulations. They have taken the "over the shoulder" approach to providing assistance, with help sequences and debriefing sessions in which actions are compared to those of other students and of experts. This trend can be characterized as a change in the perceived goals of simulations and a recognition of the student's need for didactic assistance in understanding the simulated environment.

GAMING PRINCIPLES IN SIMULATIONS

Instructional games are often categorically described as simulations by PLATO users. We believe that this occurs because games typically provide the user with a wide range of control in a fairly complete simulated environment. PLATO games such as "empire", "startrek", and "dungeons and dragons" have little, if any, mainstream instructional value, and are not under consideration in this paper. Instructional lessons which incorporate gaming principles such as competition and payoff may be regarded as simulations and will be discussed. One can say that almost all simulations have gaming elements since the user is working within a

set of constraints or rules toward a goal, and "wins" if the simulation is executed correctly, i.e., if the patient lives, the mouse learns to press the bar, or the lab is not destroyed.

Accountability in simulations may or may not reflect real-world outcomes. A surprising number of simulations evaluate the student only on the basis of successful completion, and may not reflect important limitations and costs inherent in the real-world counterpart of the simulation. The Physician Self-Assessment series of clinical simulations, translated to PLATO in the early development period utilized a "golf score" to reflect student performance. This method of scoring does not transmit specific information to the students concerning the causes of poor scores, and is frequently classed as a "cute" and somewhat irritating approach to evaluation.

Many PLATO simulations have followed the lead of early programs such as Chemistry's Qualitative Analysis of Chemical Unknowns, which assigned a relative score to each step the student took in the simulation. Step scores were graded according to difficulty and the student attempted to determine an unknown with as low a score as possible. Another previously mentioned early example is "The Identification of Bacteriological Unknowns" which assigned a realistic cost for laboratory tests, with the student attempting to obtain an accurate diagnosis of a bacterial disease at as low a cost as possible. This approach to scoring runs the risk of becoming dated when costs of procedures change. Frequent updating thus becomes important.

Aside from the "natural" gaming aspects of simulations, other game elements are built into PLATO simulations. An increasing number of PLATO lessons are based on a "total game environment" in which knowledge of a process is measured by a different set of rules. "Hospital" and "Bugs and Drugs" are examples of this trend. Both are modeled after the popular "Dungeons and Dragons" game. The student passes through a maze, in this case a hospital, encountering diseases ready to attack at each door. The student must select the proper treatment to survive. Delays or errors in judgement lead to a loss of years and perhaps life. Untreated diseases are carried along. A successful treatment gains pearls of wisdom and experience to aid in future battles against disease.

One of the advantages of large systems is that it allows inter-student competitions. Given our society, the inclusion of even comparative statistics in an otherwise mundane instructional lesson will spur student interest and effort. (These same competitive features have not been popular on European PLATO.) A majority of the approximately seventy five medical simulations available have competitive features, most commonly comparative averages of total performance scores.

The most popular competitive display is the "Hall of Fame". With the student's permission, the top twenty or thirty scores along with names or pseudonyms are listed in a "Hall of Fame". Students attempt to "bump" others in order to appear on the list. This type of competition is fairly unique to PLATO, although it draws on the tradition of names and top scores scratched on the faces of pin-ball machines.

A third type of competition is inter-terminal play between two or more players. Most programs involving direct competition are more closely aligned with traditional definitions of games than with that of simulations. Very few instructional lessons have been attempted in which active interterminal play is required. This may seem surprising, considering that devices such as competitive business simulations for management training have long been one of the more common uses of computers. However, the demand for very close coordination of the student's time and terminal availability, coupled with the use of previously mentioned approaches to inter-class competition has apparently placed this technique low of the list of development choices.

TODAY'S ENVIRONMENT

External evaluations of PLATO simulations (as with all CBE) are few and usually equivocal. Even so, the simulation format has been found most popular with students in a number of surveys, and faculty interest is high in this area. Consequently we expect continued emphasis on their development.

Communication between authors concerning the principles of lesson design has been minimal. Examples of excellect simulations have been available since the beginning of PLATO but were not widely recognized. The trends that we have presented thus reflect changes in the products of single authors or in the gross quantity of lessons produced using specific techniques. We have noticed that grand plans frequently are aborted when the novelty of PLATO development wears off. Designers who intended a simulation format to provide a hundred cases stop when they have five. In some instances the simulations were not generalized sufficiently but in many cases perseverance gives out just at the point where payoffs would soar. Since PLATO development at the University of Illinois has been increasingly decentralized into departments, it appears that continued evolution of the simulation form will be an individual adventure.

Future PLATO instructional simulations may incorporate formats which do not fit traditional definitions of simulations. One of the most lauded "instructional simulations" on PLATO is "Sentences". It allows elementary reading students to create their own mini-simulations by forming sentences with a list of available words. They can make the "House carry the girl to the dog" or "The cat jump the tree". The student is manipulating a model and is creating a process through time. The student can create any simulation as long as the rules of well-formed sentences are not broken. We suggest that this could be called an "anti-simulation". There is no active process taking place, just negative constraints. We could mention many other "simulations" on PLATO which belie current definitions but have widespread credibility with students and faculty as valid "instructional simulations".

The synthesis of sound, particularly in the forms of music and speech, has been a major research effort in the PLATO community. There is a notable relationship between "synthesis" and "simulation" in this

context, however, the relation seems more one of research than education. There are numerous examples of PLATO programs which "simulate" music and human speech. One might well argue that music is music, and producing it via a computer is no more a "simulation" than playing a piano. PLATO produced music has evolved, however, from (what now appears to be) a simple 4 voice square-wave generating synthesizer, to a 16 channel device which is fully capable of simulating a piano. Synthesis of speech is more clearly a simulation of the process of speaking. PLATO research efforts have investigated the encoding and reproduction of speech. The most significant developments to date have been methods for encoding quality speech and for translating text into speech.

CONCLUSIONS

We have presented many examples of changes in the implementation of instructional simulations on the Urbana PLATO system. Design and necessity have worked together in determining these changes. The goals of many simulations have become focused on teaching concepts rather than skills. Their implementations combine evaluation, explanation, and simulation into a total instructional experience. Competitive features are increasingly included in simulations, providing both evaluations of student performance and comparisons between students. The physical appearance of simulations is becoming less representational as developers focus in on critical features and exclude the frills. Clarification of goals, system limitations, and student pressure have all been factors in determining these changes.

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SELECTED INSTRUCTIONAL SIMULATIONS AND GAMES

Architecture

Shadowcaster
Smith, B., Parker, M., Dvorak,R., University of Arizona

This program permits the user to observe the shadow that a building will cast at any time of day for any given latitude.

Astronomy

Phases of the Moon
Avner, E. Univ. of Ill., CERL

This lesson deals extensively with concepts and terminlogy surrounding the moon and its relationship to the sun and the earth.

Biochemistry

Amino Acids, Part II: Peptide Sequence Analysis
Agee, C., Ahasic, T., U. of Ill. Medical Author Group

A laboratory simulation which allows the student to sequence short peptides of gradduated difficulty. The lesson contains an instructional section describing some of the techniques used for peptide sequencing and a simple example to demonstrate the logic used in peptide sequencing.

Biology

Fruit Fly Laboratory
Hyatt, G.W., Tenczar, P., Univ. of Ill. Zoology Department

Students conduct a standard series of fruit fly matings within a simulated environment using random numbers and probabilities based on classical Mendelian ratios adjusted, where necessary, to reflect linkage. The computer "presents" two stocks of parent flys, including mutant as well as normal characteristics. The student selects two parents for breeding at each cycle. Offspring are visually represented on the screen. The student counts the offspring, classifies them by phenotype and records the tallies on a lab sheet. Breeding instances can arrise which would challenge a professional geneticist.

Chemistry

Qualitative Organic Analysis
Smith, S., Univ. of Ill. Chemistry Dept.

This is one of the original "dialogue" format PLATO lessons. It

permits the student to determine the physical characteristics of an unknown, to perform tests and observe reactions, and to compare findings with reference data via a fairly "natural language" interchange with the computer.

Acid-Base Titration

Smith, S., Univ. of Ill. Chemistry Department

In this lesson, the student follows the steps necessary to determine the concentration of a solution by titration. The student "fills" a buret by stopping an animation at an appropriate time, requests PLATO to do the weighing and mixing, starts the titration and observes another animation of the titration process. When these steps have been successfully completed, the student does the necessary calculations to determine the concentration of the unknown. PLATO provides help with the "next" step all along the way.

Fractional Distillation Experiment

Smith, S., Univ. of Ill. Chemistry Department

The student is required to assemble the various parts of a distillation apparatus which are displayed on the screen, and then to monitor the distillation process. The student observes bath temperature, a graph of temperature at the head of te still is plotted, and the level of distillates is displayed in animation. The student tries to separate a given mixture into components as pure as possible with as little loss as possible.

Clinical Medicine

Diagnose

L. Solomon, M. Yamada, W. Bonetti, C. Nelson, Univ. of Ill. College of Medicine and the Center for Educational Development

"Diagnose" simulates the process of differential diagnosis. The student is presented with a patient complaint, then selects potential diagnoses from a list of 60 possibilities. The process is repeated after after the history, the physical findings, and the laboratory tests, eliminating additional diseases from the original list. The goal is to correctly diagnose the patient's disease. Each phase of the elimination process is reviewed, comparing the student's list of possibilities with the PLATO's "expert" choices. Students recieve a score for their performance, and high scores are kept in a "hall of fame" if the student permits.

Differential Diagnosis GI Hemorrhage

D. Trachtenbarg, R. Poncher, University of Illinois Abraham Lincoln School of Medicine, Chicago.

You are a first-year resident and see this pediatric patient in the emergency room. Your supervisor asks you questions about

many of the decisions you make to see if your knowledge of the basic medical facts is sound. You must make decisions about managing the patient in terms of history, lab, physical exam, and treatment; and are scored accordingly.

"It's a Jungle Out There"
Sabbour, M., Nelson.,C., Kemp,L., Univ. of Ill. Abraham Lincoln School of Medicine and the Center for Educational Development

Lushwell Smirnoff, 41-year-old business executive, passes out after "passing some motions" during a heated board meeting at work. He is brought to the emergency room where you are on duty on a slow night. You have an opportunity to do a history, physical, lab workup, and emergency treatment, and are scored accordingly. Summary at end.

Bugs 'n Drugs
M. Gorback, D. Tanaka, University of Maryland and Johns Hopkins Colleges of Medicine

Bugs 'n Drugs uses the "orthanc" model described above. The student wanders through a hospital labyrinth fighting diseases and gathering "pearls" of wisdom. Experience increases the ability to fight and survive by such things as immunities, better drugs, etc. The student's ready knowledge of appropriate treatments is the primary determinant of success in the game, although chance and "magic" play a role to add interest.

Computer Science

Introedit
Warner, S., Hagstrom, E., Univ. of Indiana, Bloomington

"Introedit" simulates the PLATO system text/lesson editing facility. It recreates the various displays seen in the editor, providing detailed information about each page. Controlled exercises not normally possible in the "real system editor are provided.

PDP8 Simulator
Computer Science Dept., Univ. of Ill.

The architecture of the PDP 8 computer is described along with its instruction set and concepts of programming it. Limited programs may be written and their execution is simulated by the lesson.

Elementary Math

Pizza
Dugdale, S., Kibbey, D., Leung, H., Cohen, P., and Lamprinos, S., Univ. of Ill.

The student is given the task of dividing pizzas in various ways which exercise skills in dealing with fractions. A very simple problem might involve getting 2/3 of a pizza given a "pizza cutter" that divides pizzas into 3 parts. Problems become more complex as the student progresses.

How the West was Won
Seiler, B.A., Univ. of Ill., CERL

"How the West was Won" is based on a very common children's game board format. It is a game for two players at one terminal. One of the players may be PLATO. The student is given 3 small random numbers and must combine them in some way with different arithmetic operators to arrive at a number which determines the number of squares he may move his piece on the game board. There are "safe" locations, shortcuts, and bumping rules (similar to Parchesi). The animations and graphics in this lesson are superb and it has served as a fine example of PLATO graphic capabilities for a long time.

Speedway
Seiler, B. A., Univ. of Ill., CERL

Speedway is an arithmetic facts game. The student selects the arithmetic operations to work with and selects names and game pieces for him/herself and the opponent (PLATO in this case). A "practice run" establishes a speed level for the next trial.

Engineering

Aerospace Engineering Games
Bennett, J. and Bennett, C. Univ. of Ill.

This lesson includes simulation games which permit one to try to improve the takeoff and landing performance of a light aircraft, make final design decisions for a commercial VTOL aircraft, launch a spacecraft and land on the moon.

Flight and Driver Training

Expressway Driving
Brenner, L.P., Voss, J., Univ. of Ill. Education College

A microfiche containing 165 slides simulates the drivers view of the major expressway routes within Chicago. The student uses a map to plan a route from one point to another, sets the speed of travel (in this case the speed with which slides are displayed) and touches exits to move from roadway to roadway. The evaluation of performance is based on the time taken to reach the destination.

Instrument Controlled Holding Patterns in Aviation

Trollip, S., Univ. of Ill. Aviation Institute

Students learn to fly holding patterns in differing wind conditions through manipulating a simulated airplane's controls. The touch panel and a joystick attached to the terminal are used to control the direction and speed of a simulated airplane. A graphic display of the instrument panel provides feedback to the student during the exercise. A bird's eye view of the plane's trajectory are used in instructional sequences to demonstrate the effects of wind speed and direction on the trajectory of the airplane.

Foreign Language

Japanese Telephone Quiz
Unger, J., Ashworth, D., Hebert, J., Univ. of Hawaii, Manoa Campus

This lesson presents several situations which commonly occur in telephone conversations. The student chooses among several alternative forms of response and is told whether his choice was appropriate.

Japanese Postpositions
Unger, J., Ashworth, D., Hebert, J., Univ. of Hawaii, Manoa Campus

This lesson is similar to "sentences" in that the student chooses several words from a limited set to form a sentence. This lesson provides a translation of the chosen sentence into English, but does not produce an animation.

Games

The following lessons represent some of PLATO'S most popular games. Many PLATO instructional lessons have been patterned after one or another of them and they are thus of interest.

Moonwar
Bloomfield, L., Univ. of Ill.

"Moonwar" was an early and very popular interterminal PLATO game. It consists simply of a field that players can move about on, hiding behind obstructions or "mountains", and firing weapons at opponents who come into view. The player directs a shot by entering a deflection angle. (Avid players become very adept at estimating angles.) The lesson was one of the first to introduce the concept of the "big board", a display where players can issue or accept challenges, send messages, and generally attend to preparing for competition.

Dogfight
Green, D.J., White, L.A., Univ. of Ill.

Dogfight is another very early example of a PLATO inter- terminal game. Its rules are even simpler. The student's "plane" moves about the screen in fairly slow animation, maintaining its current direction. Direction of movement can be changed in 45 degree increments by pressing an appropriate "arrow" key (the keys azxcdewq on a PLATO keyset have arrows pointing east, southeast, south, etc.). The "s" key is used to "shoot" at an opponent. The restriction limiting changing direction to 45 degree steps was incorporated to simulate the limitations imposed by inertia on "real" vehicles. Dogfight also uses a "big board" for arranging matches between opponents.

Airfight

Fortner, B., Univ. of Ill., CERL

Airfight is a much more complex air battle simulation. Players select one of a number of possible fighter planes and decide if its characteristics are suitable. Then they choose a "team" to play on, and then attempt to "take off". A simplified instrument panel is displayed, along with a "radar" display which shows the location of comrades and opponents. A simplified view of the world is visible via a "windshield" in the display. There are controls for the rudder, throttle, flaps, etc., for "flying" the plane. Flight characteristics of the plane are simulated as closely as possible. Once airborne, players pursue the "enemy" and fire missles in combat. This game is painfully slow when there are large numbers of users on PLATO.

Orthanc

P. Resch, L. Kemp, E. Hagstrom, Univ. of Ill.

"Orthanc" is a "Dungeons and Dragons" game in which the player wanders through a labyrinth encountering monsters who guard treasures and magical wonders which he may choose to fight for. Game rules are very complex. The ultimate object of the game is to acquire "experience" and retire to the King's hall of fame.

Empire

Miller, C., Fritz, G., Univ. of Ill.

Empire may be the most widely played game on PLATO. The number of games played over the past 3 years is in the millions. It is an interterminal combat game which involves flying a "starship" and battling starships from other teams (up to 4 teams may be playing at a time), and conquering planets. A game is complete when a team has conquered all the planets in the universe.

Genetics

Medical Genetics Laboratory: Metabolic Diseases and Medicine

Li, I-Chian, Daniel, W., Brenner, L., Schultz, S., Univ. of Ill. School of Basic Medical Sciences, Urbana.

Two patients are presented, each with a metabolic disease. The

student is provided with access to clinical, laboratory, and family data; and is expected to diagnose the specific disorder, provide a description of the molecular basis of the disease, and provide recuurrence risks to the patient. An analysis of student performance is provided at the end of each case.

Histology

Cutthroat Histology: Competitive Interterminal Drill on Tissues and Organs
McCormick, T., Gaburo, K., Univ. of Ill. Medical Author Group

This lesson features the identification of tissues and organs from over 200 photomicrographs on a microfiche. A photomicrograph is displayed on the PLATO "screen" for 10 seconds. A series of two to six multiple choice questions related to that photomicrograph follow for the student to answer as fast and as accurately as possible. The student may challenge another student at another PLATO terminal, or challenge a "built-in" PLATO "phantom" to match wits on the same picture and questions. An opportunity to review the photomicrographs and associated questions is available.

Management

Specification Buying
Kraatz, J., Rud, E. University of Illinois, CERL

In this lesson, the student must visit various departments in the corporate offices of a large merchandising company to determine appropriate manufacturer's specifications for an item to be added to the company's hardware line. The student's specifications are evaluated according to whether the product meets manufacuring standards, the company's standards, and standards of profitability.

Busline
Silas Warner, Univ. of Indiana, Bloomington

"Busline" simulates management of the fare schedule for a bus line between several cities. At each stop, passengers get on and off the bus. Ridership depends on the fare and is limited by the size of the bus. The aim is to show a profit.

Mathematics

Closeup
Axel Schreiner, Univ. of Ill.

Closeup simulates various approximation methods, such as the method of successive approximation, Newton's method, and the method of false position (regula falsi) for the solution of equations of the form $f(x)=0$, and can display a sequence of

Taylor and Fourier approximations to a given function.

Microbiology

Microstakes I and II, Respiratory Infections and Gastrointestinal Infections

Wagner, K., Johnson, M., Cohen, P., Univ. of Ill. Medical Author Group

Modeled after the TV game Jeopardy, these lessons allow students to compete against each other over a variety of topics.

Military Communications

Tactical Computer System

This lesson simulates the displays, input/output formats, and communications options for a military computer system. It includes descriptions of the system, differences between the real system and PLATO, and allows interaction with the simulated system and with other users of the system in a realistic way.

Music

Guido Interval Lesson

Hofstetter, F., Lynch, W. University of Delaware

This lesson uses the Gooch Synthetic Woodwind (GSW) music synthesizer for training auditory recognition of intervals on a musical scale. The lesson permits the student to hear any interval on request, quizzes the student, and presents intervals in a game format in which the student attempts to esablish a low average time of identification over a number of trials. "Good" scores go into a "hall of fame".

Nursing

Tic Tac Toe

Staatse, C., Gordon, S., Predmore, J., Parkland College

Tic Tac Toe is a game for maternity nursing students in which players may play against one another, or against PLATO. The object is similar to the traditional game of the same name. The difference is that the student must answer a question about a selected topic before her "X" or "O" will be placed in a chosen location.

Pharmacology

Pharmer: A Game for Phun with Pharmacy

Lambert, G., Guerra, C., Univ. of Ill. College of Pharmacy

An interterminal game in which students match wits on various aspects of pharmacy. Includes contests concerning generic names

of drugs, trade names of drugs, and Latin abbreviations.

Physics

Racetrack

Nievergelt, J., Univ. of Ill, Computer Science Department

"Racetrack" is a game which simulates accelerated motion in discrete intervals. By pressing keys which indicate the direction in which a force is to be applied, a simulated car is moved over a race track. The object of the game is to stay on the track (much more difficult than it sounds) and to reach a goal in a minimum number of steps. This lesson was an immediate "hit" as a game, and has served as a classic model for many other PLATO simulations which operate on similar principles.

Compton

Bennett, C., Univ. of Ill., Physics Department

This lesson illustrates the Compton effect and permits the student to observe the effect when photons of any selected energy strike a target of selected mass with a selected scattering angle.

Population Dynamics

Population Dynamics

Population Dynamics Group, Paul Handler, director.
Univ. of Ill.

"Population Dynamics" is a set of lessons containing extensive demographic data representing many models including population growth, food production, energy consumption, education, weather patterns and other miscellany.

Psychology

Dilemma

Wagman, M., Kerber, K., Univ. of Ill.

"Dilemma" teaches a method for solving life-choice problems and provides counseling for a current psychological dilemma. It consists of a general introduction to the dilemma counseling method, practice in phrasing problems as dilemmas, practice in generating solutions to these dilemmas, and applications of the dilemma counseling method to the user's own problem.

Mouse

Avner, R.A., Univ. of Ill. CERL

"Mouse" provides a simulated operant conditioning laboratory, a review of operant conditioning terminology, and sections demonstrating and reviewing reinforcement schedules and their effects.

Political Science

Candidate

Peters, J., Emerick, D., Univ. of Ill. Political Science Dept.

In lesson "Candidate", the student campaigns for election to congress. Steps include allocating funds for advertising, and polling the constituency. The "candidate" must determine the opponent's position, attitudes of the voters, and take appropriate stances on various sensitive issues which are likely to meet with approval. Sucess is winning the election.

Union Leader

Emerick, D., Univ. of Ill. Political Science Department

In "Union Leader", the student plays the role of the leader of a teacher's union negotiating with the local board of education. The board consists of members having widely variant educational philosophies. The leader must take stands on issues such as discipline, class size, and salaries which the board will approve, without alienating the union membership.

Reading

Hangman

Micheal, G., Berger, M., Dennis, D., Jones, D., Univ. of Ill.

Lesson "Hangman" is the familiar word game in which one attempts to guess an unknown word a letter at a time. Each incorrect guess adds a part to the man to be hanged, and when the man is complete the trapdoor falls. The lesson adds drama to the game by developing an elaborate medieval tale of a search for members of a secret cult. One can be saved from the inquisitor by finding the unknown words. Insulting the inquisitor makes the game harder.

Sentences

Yeager, R.F., Univ. of Ill. CERL

"Sentences" allows a student to select words from a limited set to form a complete sentence, such as "The boy runs from the house to the car". The program interprets the meaning of the sentence and displays an animation of a boy running from a house to a car. The lesson is available in English German, or Swedish. Random-access or computer synthesized audio output is available.

Secondary Education

Tenure

Gaede, O., Georgia Southern College.

One is confronted in "tenure" with the decisions typical of those before a new teacher in a public school. During the course of

the game, the player is given clues concerning the Principal's educational stance (which varies randomly in different games) and must make decisions in various situations which may please or alienate the school administration. When the game is complete, the player is retained, fired, given a raise, and/or awarded tenure, depending on the degree to which the player's decisions matched the administration's expectations.

Veterinary Medicine

Identification of Hormones

Jackson, G, Trynda, R, Univ. of Ill. College of Veterinary Medicine

The student is given an unknown hormone to identify. Information can be requested about various effects of the hormone. The score is reduced with each request Students try to make an identification with as high a score as possible. Scores may be compared with average scores for each hormone.

Nervewar

Martin, G., and Smith, B., Univ. of Ill., Veterinary Medicine College

An interterminal game in which students attempt to match muscles with their ennervations. Based on Miller's Dissection Guide to the Dog.

Identification of Bacteriological Unknowns

Rhoades, H.E., North, L.R., Univ. of Ill. Veterinary Medicine College

In this simulated bacteriological laboratory the user selects a clinical case, obtains clinical information, selects a specimen, cultures the organism and performs tests on the resulting colonies. A variety of agars, broths, stains, biochemincal tests and biologic tests may be used. When the unknown is identified, test results are compared to 99 common bacterial species to see if sufficient data was gathered to confirm the identification.

Population Laboratory

Woll, J., Univ. of Ill. Veterinary Medicine College

The user can study the effects of density independent and density dependent environmnental factors on the growth of E. coli Under conditions specified by the student, growth curves are graphed as through measured by a spectrophotometer. A summary quiz requires the student to generalize findings to other populations.